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THE OYSTER-SHELL SCALE[1] AND THE SCURFY SCALE.[2]

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INTRODUCTION.

The oyster-shell scale [1] and the scurfy scale [2] are, with the exception of the San Jose or Chinese scale,[3] more frequently the subject of

FIG. 1.—Oyster-shell scale (*Lepidosaphes ulmi*) on poplar. Much enlarged. (Authors' illustration.)

inquiry by orchardists than all other species of scale insects combined. These two scale pests are now very generally distributed

[1] *Lepidosaphes ulmi* L. [2] *Chionaspis furfura* Fitch. [3] *Aspidiotus perniciosus* Comst.

throughout the country, and from their relatively conspicuous appearance are often detected by observant fruit growers who frequently believe them to be the more serious San Jose scale. The oyster-shell and scurfy scales, while not dangerous in the sense of generally causing the death of infested trees, are, however, of considerable economic importance. The complete killing of individual branches of apple trees by either species is a matter of frequent observation, and trees so badly infested are frequently greatly stunted and retarded in their growth, resulting perhaps in extreme cases in the death of the trees. Of the two species considered, the oyster-shell scale has been and is at the present time the more important. Its injuries to certain shade trees, especially poplar and maple, have been the cause of much complaint during recent years. Such shade trees are ordinarily not sprayed for scale insects, and the increase of these pests from year to year is thus checked only by their natural enemies. The writers have frequently seen maple and poplar trees literally incrusted from top to bottom with the oyster-shell scale, many of the limbs killed, and in rarer instances the trees quite dead, without doubt owing to the attack of this scale insect.

THE OYSTER-SHELL SCALE.

ORIGIN AND DISTRIBUTION.

The origin of the oyster-shell scale is a matter of some uncertainty. It has a world-wide distribution, and was introduced into the New England colonies at an early date. The first American account of this insect was written by Enoch Perley in 1794, and in it he stated that the pest was doing considerable damage to the apple in Cumberland County, Me. Shortly after 1860 it had reached the Mississippi River, and at the present time occurs in every State of the Union with the possible exception of South Dakota, Oklahoma, and Texas. Its occurrence in these States is practically certain, but there appear to be no records in literature to this effect, and it has not been received from these States by the Bureau of Entomology. The insect is very troublesome in the Northern States and is especially common in the New England States and those bordering the Great Lakes.

DESCRIPTION AND LIFE HISTORY.

This insect has received the common name "oyster-shell scale," owing to the resemblance of its scale, or covering, to a long narrow oyster shell, as may be seen by reference to figures 1 and 2. The adult female scales are about one-eighth of an inch in length, usually brown to dark brown in color, though occasionally they have a grayish appearance which is due to bleaching over winter. If present in large numbers, for want of room they assume various more or less

curved shapes. The scale of the male in shape and color resembles that of the female, but is smaller and possesses at the posterior extremity a small hinge or flap which permits the exit of the adult male.

If during winter or early spring one of the female scales be removed, numerous small, oval, white eggs varying in number from 40 to 100 will be revealed, and at the anterior portion can be seen the dead and shriveled body of the female.

In Canada and the Northern States there is thought to be but one full brood annually, whereas in the Middle and Southern States the species is double brooded.

The following records from literature and from the Bureau of Entomology will indicate the time in the spring of hatching of the eggs of this insect, in various localities. This time will of course vary with the season, but in general, as long ago stated by Dr. Mygatt in Illinois, will for any locality be shortly after the time of the falling of the blossoms of the apple.

FIG. 2.—The oyster-shell scale (*Lepidosaphes ulmi*). Enlarged. (Authors' illustration.)

Ontario: Eggs hatch about first week of June (Jarvis).

New York: Eggs hatch latter part of May to early June (Felt).

New Hampshire: Eggs hatch in late May to early June (Sanderson).

Vermont: Eggs hatch in late June (Stewart).

Maine: Eggs hatch about middle of June or later, depending upon the season (Hitchings).

Michigan: In specimens received June 18, 1909, from Stittsville, Mich., nearly all eggs had hatched (Sasscer).

Minnesota: In specimens received May 24, 1909, from Lamoille, Minn., eggs were hatching in numbers when received (Sasscer).

Indiana: In specimens received from Elwood, May 14, 1909, eggs were hatching in numbers when received (Sasscer).

Ohio: Eggs hatch in late May to early June (Gossard).

Second-brood eggs were found under many scales August 22, and a few young crawling at Cleveland (Quaintance).

West Virginia: In specimens received April 30, 1908, from Parkersburg, W. Va., young were crawling in numbers (Sasscer).

Missouri (Wright County): Eggs hatch early in May. Insect double brooded according to a Mr. Wright (Riley).

Olden, Mo., eggs hatched March 29, 1907; apple trees bloomed March 24 (Girault).

Ozark region, Missouri, eggs hatch about April 25 to middle of May (Taylor).

Illinois (Cook County): Eggs hatch about June 6, females reach full growth by August 1, and oviposit August 12–28 (Riley).

District of Columbia: Eggs hatch May 5–14 (Quaintance).

July 4, eggs already deposited by most females and young crawling (Quaintance).

Maryland: Eggs hatch early in May (Symons).

Eggs of first brood hatch in May; eggs of second brood hatch in last week of July to first week of August (Johnson).

College Park, many recently settled scales in evidence May 21 (S. W. Foster).

Delaware: Eggs usually hatch in early May (Houghton).

New Jersey: Eggs hatch during early June (Smith).

Tennessee: In eastern Tennessee eggs hatch during first two weeks of April (Chambliss).

Eggs begin to hatch in April and those of the second brood along in July and August (Bentley).

This information as to the period of hatching of eggs in various parts of the country is of importance as bearing on the time to spray for the destruction of the young larvæ.

The female molts twice in the course of her growth, and in the adult condition is entirely without legs or eyes, being nothing more than a reproductive sack with her sucking mouth parts, through which the food is taken, inserted in the tissues of the plant. The adult male differs radically from the female in that it is provided with antennæ and one pair of wings, the second pair being present in the form of club-shaped organs known as balancers or halteres. During the process of change the mouth parts entirely disappear, and a second pair of rudimentary eyes assumes their place. Being without any means of taking in food, the male is naturally very short lived, its only mission appearing to be the fertilization of the female.

MEANS OF DISTRIBUTION.

Transportation by nursery stock, scions, or grafting or budding material is perhaps the only way this insect is carried from one section of the country to another, and this in a large measure accounts for its wide distribution. Locally it can be transferred from plant to plant only while in the young or crawling stage. The young are often seen crawling on other insects, such as beetles, or upon the feet of birds, and may in this way be carried some distance. Man and domestic animals may also assist in their dissemination, and it is possible that the winds blow them from plant to plant.

FOOD PLANTS.

The oyster-shell scale has a wide range of food plants, but is commonly found on apple, maple, horse-chestnut, poplar, willow, and lilac. The following is a list of the plants on which it is known to occur throughout the world:

Alder (*Alnus rugosa* Spreng.).
Almond (*Prunus* sp.), China.
American aspen (*Populus tremuloides* Michx.).
American bladdernut (*Staphylea trifolia* Linn.).
Amorpha sp.
Andromeda sp.
Apple (*Malus sylvestris* Miller).
Apple, crab (*Malus* sp.).
Apricot (*Prunus armeniaca* Linn.).
Arrow-wood (*Viburnum* spp.).
Ash (*Fraxinus americana* Linn.), (*F. excelsior* Linn.), (*Fraxinus* spp.).
Barberry (*Berberis* sp.).
Balm of Gilead (*Populus balsamifera* Linn.).
Basswood (*Tilia americana* Linn.), (*T. angustifolia*).
Beech (*Fagus atropunicea* Sudw.).
Bilberry (*Vaccinium myrtillus* Linn.).
Birch, white (*Betula populifolia* Ait.).
Birch, river (*Betula nigra* Linn.).
Bittersweet (*Celastrus scandens* L.).
Blackthorn (*Prunus spinosa* Linn.).
Blueberry (*Oxycoccus* sp.).
Box (*Buxus sempervirens* Linn.).
Boxelder (*Acer negundo* Linn.).
Broom (*Cytisus scoparius* Link.), Gurnsey. (*C. nubigensus* Link.), from Gurnsey (?).
Buckeye (*Aesculus glabra* Wild.).
Buckthorn (*Rhamnus cathartica* Linn.).
Butternut (*Juglans cinerea* Linn.).
Calluna sp.
Camellia sp.
Camphor tree (*Cinnamomum camphora* (L.) Nees & Eberm.).
Cassia sp., in greenhouse.
Cherry (*Prunus* sp.).
Chestnut (*Castanea americana* Raf.).
Clematis paniculata Thunb.
Cocoa palm (*Cocos nucifera* L.).
Cotoneaster sp.
Cranberry (*Oxycoccus* sp.).
Currant, black (*Ribes nigrum* Linn.).
Currant, mountain (*Ribes alpinum*).
Currant, red (*Ribes rubrum* Linn.).
Dogwood (*Cornus alba* Linn.), (*C. alba* var. *sibirica* Lodd.), (?*C. alterna* Marsh), (*C. californica* C. A. Mey), (*C. sanguinea* Linn.).
Elm, English (*Ulmus campestris* Smith).
Elm, purple-leaved (*Ulmus scabra* var. *purpurea* Koch).
?*Euphorbia palustris* Linn., Germany.
False bittersweet (*Celastrus scandens* Linn.).
Fig (*Ficus carica* Linn.).
Filbert (*Corylus* sp.).
Ginseng (*Panax quinquefolium* Linn.).
Gooseberry (*Ribes cynosbati* Linn.).
Goatsbeard (*Aruncus sylvester* Kost.).
Grape (*Vitis vinifera* Linn.).
Hackberry (*Celtis occidentalis* Linn.).
Hawthorn (*Crataegus crus-galli* Linn.), (*C. oxyacantha* Linn.).
Helianthemum chamaecistus Mill., England.
Heath (*Erica* sp.), England and Sweden.
Heather (*Calluna* sp.).
Holly (*Ilex crenata* Thunb.).
Honeysuckle (*Lonicera* sp.).
Hop tree (*Ptelea trifoliata* Linn.).
Horse-chestnut (*Aesculus hippocastanum* Linn.).
Hovenia inaequalis.
June-berry (*Amelanchier* spp.).
Leather leaf (*Chamaedaphne calyculata* Moench).
Lilac (*Syringa persica* Linn.), (*S. vulgaris* Linn.).
Lime (*Citrus* sp.).
Linden. (*See* Basswood.)
Locust, cultivated (*Robinia pseudacacia* Linn.).
Locust, water (*Gleditsia aquatica* Marsh).
Maple, red (*Acer rubrum*).
Maple, striped (*Acer pennsylvanicum* Linn.).
Maple, sugar (*Acer saccharum* Marsh).
Maple, mountain (*Acer spicatum* Lam.).
Mespilus cuneata Miq.
Moose-wood (*Dirca palustris* Linn.).
Mountain ash (*Sorbus americana* Marsh).

Mountain ash, European (*Sorbus aucuparia* Linn.).
Myrtle (*Myrtus* sp.).
Nectarine (*Amygdalus persica nectarina* Ait.).
New Jersey tea (*Ceanothus americanus* Linn.).
Oak (*Quercus pedunculata* Ehrh.), (*Quercus* spp.).
Orchid.
Pachysandra terminalis Sieb. & Zucc.
Peach (*Amygdalus persica* L.).
Pear (*Pyrus communis* Linn.).
Pear, Seckel.
Peony (*Paeonia* sp.).
Peppergrass (*Lepidium suffruticosum* Linn., Cav.).
Planera keakei C. Koch.
Plum (*Prunus domestica* Linn.).
Poplar, Carolina (*Populus deltoides*).
Poplar, Lombardy (*Populus nigra* var. *italica* Du Roi).
Poplar, white (*Populus alba* Linn.).
Prunus sargentii.
Quince (*Cydonia vulgaris* Pers.).
Raisin tree (*Hovenia dulcis*).
Raspberry (*Rubus* spp.).
Rhamnus sp.
Rose (*Rosa rugosa* Thunb.).
Sassafras (*Sassafras sassafras* Karst.).
Silverberry (*Elaeagnus argentea* Pursh.).
Spiraea spp.
Spruce (*Abies firma* Sieb. & Zucc.).
Sunflower (*Helianthus* sp.).
Sycamore (*Platanus* sp.).
Tallow tree (*Sapium sebiferum* Roxb.).
Tamarisk (*Tamarix africana* Poir.).
Tree of Heaven (*Ailanthus cacodendron* [Ehrh.] Schinz. & Thell.).
Tulip-tree (*Liriodendron tulipifera* Linn.).
Umbrella tree (*Magnolia tripetala* Linn.).
Viburnum sp.
Virginia creeper (*Ampelopsis quinquefolia* Michx.).
Willow, goat (*Salix caprea* Linn.).
Willow, Napoleon (*Salix babylonica* Linn.).
Willow, osier (*Salix viminalis* Linn.).
Willow (*Salix aegyptiaca* Forsk.).
Willow (*Salix pedicellata* Desf.).
Walnut, English (*Juglans regia* Linn.).
Walnut (*Juglans* sp.).
Yucca (*Yucca* sp.).

PARASITIC AND PREDACEOUS ENEMIES.

Minute parasitic wasps are often efficient enemies of this scale, and in some localities they apparently hold the insect in check. If these little friends [1] are present, small round holes can be seen on the dorsal part of the scale showing where the adult escaped.

The larvæ of coccinellids, or ladybeetles, are sometimes found feeding on these insects, and certain species of mites assist in their destruction. Birds are also credited with doing service, the most efficient being the titmice and tree creepers.

THE SCURFY SCALE.

The scurfy scale, while infesting a considerable number of plants, is a less general feeder than is the preceding species. It occurs principally upon rosaceous plants, such as the apple, peach, pear, plum, cherry, etc., and also on currant and gooseberry among cultivated plants, but seldom becomes so abundant as to cause particular injury or to require specific treatment. The insect may be recognized from the accompanying illustration (fig. 3), much enlarged. The scale of the female is dirty gray in color, irregularly pear-shaped, as shown in the picture. The male scales are much smaller, elongate, snowy white,

[1] Those more commonly found are *Aphelinus mytilaspidis* Le B., *A. abnormis* How., *A. fuscipennis* How., *A. diaspidis* How., *Aspidiotiphagus citrinus* How., *Anaphes gracilis* How., and *Cheiloneurus diaspidinarum* How.

with three distinct keels extending longitudinally along the back. Unlike the former species, the scurfy scale is a native North American insect, and appears to be less adaptable to the various conditions throughout the country, and has thus a more restricted distribution.

LIFE HISTORY AND HABITS.

The scurfy scale, like the oyster-shell scale, winters in the egg condition under the scales. The number which may be deposited by a

FIG. 3.—The scurfy scale (*Chionaspis furfura*). Male at right, female at left. All enlarged. (Authors' illustration.)

given female, as may be easily verified by examination, varies considerably. The following records show the number of eggs from each of twenty individuals:

Number of eggs deposited by the scurfy scale. (Material collected on apple sprouts from base of apple stump March 31, 1905, at Arlington Farm, Virginia.)

Scale No.	Eggs.	Scale No.	Eggs.	Scale No.	Eggs.	Scale No.	Eggs.
1	61	6	74	11	54	16	82
2	18	7	78	12	61	17	23
3	78	8	70	13	48	18	83
4	98	9	19	14	68	19	21
5	53	10	41	15	78	20	33

Average number of eggs per scale, 57.5.

The following records from literature and from the Bureau of Entomology will indicate the times of hatching of the eggs of this insect in the spring for several localities:

Ontario: Eggs hatch about June 1 (Jarvis).

Connecticut: Eggs hatch usually between May 20 and June 1 (Britton).

New York: Eggs hatch at about same time as those of oyster-shell scale.

Ohio: Eggs hatch, and young are crawling, during latter part of May or in early June (Houser).

Illinois: Eggs hatch from June 5 to 12 (Walsh).

Missouri: Eggs hatch soon after the formation of the young apples, the date depending upon locality and upon forwardness of the spring (Taylor).

District of Columbia: Eggs hatch from May 15 to June 1 (Howard).

Delaware: Eggs hatch about same time as those of oyster-shell scale, which is usually early in May (Houghton).

Tennessee: Eggs hatch in April, and there are two broods annually (Bentley).

Georgia: In 1906 eggs hatched March 11 to 22. Eggs for second brood hatched beginning about June 2.

In the more northern States there is but one brood each year, but in the South, as in Tennessee and in Georgia, there are evidently two full broods, and in the latter State there is a strong probability of a third. Thus, at Myrtle, Ga., in 1906, the eggs were hatching March 11, and hatching had probably ceased by March 22. Males of the new brood appeared May 15, and eggs had been deposited by the female May 28, the hatching beginning June 2.

DISTRIBUTION.

The following records of distribution have been compiled from various publications and from data collected by the Bureau of Entomology:

California, Colorado, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, West Virginia, and Wisconsin. In Canada it is recorded from New Brunswick, Nova Scotia, Ontario, and Prince Edward Island.

FOOD PLANTS.

The list which follows includes all plants upon which this species has been found, so far as it has been possible to determine from records in literature and from those in the Bureau of Entomology.

Apple (*Malus sylvestris* Miller).
Apple, Chinese flowering (*Malus spectabilis* Ait.).
Apple, crab (*Malus* sp.).
Ash, European mountain (*Sorbus aucuparia* Linn.).
Ash, mountain (*Sorbus americana* Ait.).
Ash, prickly (*Xanthoxylon americanum* Mill.).
Ash, white (*Fraxinus americana* Linn.).
Aspen, largetooth (*Populus grandidentata* Michx.).

Buckthorn (*Rhamnus cathartica* Linn.).
Cherry, choke (*Prunus virginiana* Linn.).
Cherry, wild black (*Prunus serotina* Ehrh.).
Cherry, wild red (*Prunus pennsylvanica* Linn.).
Chokeberry, black (*Aronia melanocarpa* [Michx.] Elliott.
Chokeberry, red (*Aronia arbutifolia* [L.] Pers.
"Cherry currant."
Cotton (*Gossypium* sp.).
Currant, black (*Ribes nigrum*).
Currant, red flowered (*Ribes sanguineum* Pursh.), England.
Elm(*Ulmus* sp.).
Gooseberry (*Ribes* sp.).
Hawthorn (*Crataegus oxyacantha* Linn.).
Hickory, big bud (*Hicoria alba* Britt.).
Horse chestnut (*Aesculus hippocastanum* Linn.).
Maple (*Acer* sp.).
Peach (*Amygdalus persica* L.).
Pear (*Pyrus communis* Linn.), (*P. heterophylla* Dur.) (*P. melanocarpa*).
Plum, purple-leaved (*Prunus pissardii* Hort.).
Plum, common garden (*Prunus domestica* Linn.).
Quince (*Cydonia vulgaris* Pers.).
Quince, Japan (*Chaenomeles japonica* [Thunb.] Lindl.).
Raspberry, black cap (*Rubus occidentalis* Pers.).
Red-twigged dogwood (doubtful record).
Shad-bush (*Amelanchier canadensis* Medic.).
Sweet gum (*Liquidambar styraciflua*).
Sweet pepper bush (*Clethra alnifolia* Linn.).
Walnut, black (*Juglans nigra* Linn.).
Willow, white (*Salix alba* Linn.).

The scurfy scale is especially common on apple and pear, less usually so on cherry and peach, on which latter host in the South, in certain cases which have come under the writers' observations, it proved very destructive, greatly stunting the trees, although none had actually been killed.

PARASITIC AND PREDACEOUS ENEMIES.

This species is apparently not so subject to attack of parasitic and predaceous insects as the preceding, or else attention has not been directed to this phase of the insect's economy to an equal extent.[1]

METHODS OF CONTROL FOR BOTH SPECIES.

Preparatory to spraying orchard, shade, and ornamental trees and plants for scale insects, they should be carefully gone over and any dead and weakened parts pruned out. The presence of such dead and dying wood is a distinct detriment, and its removal will greatly simplify the work of spraying.

TREATMENT OF ORCHARDS.

In orchards well sprayed during the dormant period for the San Jose scale each year, the oyster-shell and scurfy scales should rarely prove troublesome. While these insects, by reason of their wintering in the egg stage under the protecting female scales, are less susceptible to washes effective against the San Jose scale, yet the treatments will in most cases keep them reduced below injurious numbers.

[1] The following predaceous species are recorded as feeding upon the scurfy scale: *Tyroglyphus malus* (Shimer), *Chilocorus bivulnerus* Muls., and *Hyperaspidius* sp.

Among the parasitic Hymenoptera *Ablerus clisiocampae* (Ashm.) has been reared from this species as well as *Physcus varicornis* How.; and a species of the genus Prospaltella.

In orchards where spraying for the San Jose scale is unnecessary and where the oyster-shell and scurfy scales are troublesome, specific treatments become desirable. There is considerable difference of opinion among entomologists as to the effectiveness of sprays applied during the dormant season to effect the destruction of the eggs. There is greater uniformity of opinion, however, as to the effectiveness of spraying shortly after the young have hatched and before there has been time for the formation of a thick protecting scale.

Recent observations and experiments, especially those by Messrs. E. W. Scott and W. S. Abbott in connection with the enforcement of the Insecticide Act of 1910, indicate that lime-sulphur wash is adequately effective against the oyster-shell scale applied during the dormant season, exactly as is done for the control of the San Jose scale. The lime-sulphur wash appears to seal the eggs and young under the scale covering, and probably also acts as a deterrent to the settling of the young lice on the twigs and branches. The effectiveness of such treatments, however, would probably vary with weather conditions which would tend to interfere with the "sealing" action of the wash. It is recommended, therefore, that orchardists use for the control of the oyster-shell and scurfy scales the lime-sulphur wash now in general use against the San Jose scale. A single dormant-tree treatment should be effective in controlling these three scale insect pests. It is essential, however, that very thorough applications be made, and in the case of large apple trees with a good deal of rough bark on the limbs and branches, this should be scraped off where practicable, since many of the scale insects will find protection under the loose pieces of bark.

If for any reason the dormant-tree treatment has not been satisfactory, as shown by the abundance of young scales hatching in the spring, an additional spraying, using kerosene emulsion or fish-oil soap wash, may be desirable, directed against the "lice" just hatched. The records of dates of hatching given under the remarks on life history for each species will indicate approximately when the young insects may be expected to appear, but this time may be accurately determined by frequent examinations of infested trees. The very small, yellowish insects will be seen in numbers crawling over the limbs and branches in their efforts to find a suitable place for settling. In general, the young of both species will have hatched and settled, and may be effectively treated during the period of from one to three weeks following the blooming period of the apple, and from two to four weeks after the blooming period of the peach. It will be preferable, however, to determine positively the time of crawling of the young for the particular locality and food plant by actual observations.

In spraying for the young insects when the trees are in foliage, the presence of the foliage will render thorough work more difficult, and special care will be necessary to reach all limbs and branches, treating every portion of the tree from top to bottom, as only those insects actually hit are destroyed. Dilute lime-sulphur wash, as used for fungicidal purposes, while of considerable value in destroying the newly hatched insects, is not as effective as kerosene emulsion or fish-oil soap wash, later mentioned under the head of formulas.

TREATMENT OF SHADE TREES.

The oyster-shell scale will often require treatment on maples, Lombardy and Carolina poplars, ash, and willow. Such trees should be sprayed with the strong lime-sulphur wash during the dormant period as advised for fruit trees, and if the insects have not been satisfactorily controlled, a supplemental treatment with kerosene emulsion or fish-oil soap wash should be made as the young are hatching. Effective spraying of shade trees, where these are of some size, will require painstaking work. In many cases it will be necessary for the man handling the nozzle to climb into the trees to reach the higher limbs and branches, and a long extension or bamboo rod is indispensable. The length of hose must be adapted to the height of the trees to be treated, and a coarse nozzle will be preferable, since it enables the operator to throw the spray some distance to inaccessible branches. A high pressure pump, from 150 to 200 pounds, is essential, though the writers have seen good work accomplished with an ordinary barrel outfit.

TREATMENT OF CURRANTS, GOOSEBERRIES, ORNAMENTAL SHRUBS, AND OTHER LOW-GROWING PLANTS.

After proper pruning, shrubs and bushes infested with these two scale pests should be thoroughly sprayed during the dormant period with the strong lime-sulphur wash as indicated for orchard and shade trees. If desirable, a supplemental treatment may be made as the young are hatching, as already indicated. A knapsack or bucket pump will be suitable for treating a few plants in yards, though if the amount of spraying to be done is considerable, a barrel pump would be preferable. Where infested yard plants are growing close to the wall of the building, this may be protected during the operation of spraying by a piece of tarpaulin, or other heavy cloth, or even waste paper.

SPRAY FORMULAS.

KEROSENE EMULSION (STOCK SOLUTION, 66 PER CENT OIL).

Kerosene emulsion is made after the following formula:

Kerosene (coal oil, lamp oil)	gallons	2
Fish oil or laundry soap (or 1 quart soft soap)	pound	½
Water	gallon	1

First dissolve the soap in boiling water; then remove the vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock emulsion may be more conveniently made by pouring the mixture into the tank of a spray pump, and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if well made, will keep for some months, and is to be diluted before use. To make a 10 per cent spray (the strength for trees in foliage) add to each 1 gallon of the stock solution about $5\frac{2}{3}$ gallons of water. For 20 and 25 per cent emulsions (for use on dormant trees and plants) use respectively about $2\frac{1}{3}$ and $1\frac{2}{3}$ gallons of water for each 1 gallon of stock emulsion. Agitate the mixture in all cases, after adding the water. The preparation of the emulsion will be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap, in water, when thoroughly agitated. Double the quantity of naphtha soap given in the above formula, however, will be required, and soft or rain water should be used in making the emulsion. In regions where the water is "hard" this should first be broken with a little caustic potash or soda, as common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene, or rain water may be employed.

CRUDE PETROLEUM EMULSION.

Crude petroleum emulsion may be prepared in identically the same way as has just been described for kerosene emulsion, crude petroleum being substituted for kerosene. The grade of crude petroleum employed in the East is that known as "insecticide oil," having a specific gravity of 43° to 45° Baumé. The same dilutions for winter and summer spraying should be observed as stated for kerosene emulsion, but it should be noted that for summer treatments of trees in foliage the kerosene emulsion is preferable, as it is less likely to cause injury.

FISH-OIL SOAP WASH.

There are several brands of fish-oil soap on the market. Potash soap is preferable, and it should not contain over 30 per cent of water. For spraying dormant trees the soap is dissolved in hot water at the rate of 2 pounds to each 1 gallon, and spraying should be done before the wash cools, otherwise it is forced through the nozzle with difficulty. For spraying trees in foliage use the soap at the rate of 1 pound to 3 or 4 gallons of water, or even weaker.

LIME-SULPHUR WASH.

A good lime-sulphur wash may be made for immediate use by the following formula:

Stone lime	pounds	20
Sulphur (flour or flowers)	do	15
Water to make	gallons	50

Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot add all the lime and at once add all the sulphur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water should be added, preferably hot, and the cooking should be continued for one hour, when the final dilution may be made, using either hot or cold water, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam, no stirring will be necessary. After the wash has been prepared it must be well strained as it is being run into the spray tank. It may be cooked in large kettles, or preferably by steam in barrels or tanks. This wash should be applied promptly after preparation, since, as made by this formula, there is crystallization of the sulphur and hardening of the sediment upon cooling. While an excess of lime, as in the above formula, adds nothing to the effectiveness of the wash, it serves by its color to indicate how thoroughly the trees are being coated. Another formula, with just sufficient lime for union with the sulphur, is employed by many orchardists in the preparation of the wash for immediate use as follows:

Stone lime	pounds	7½
Sulphur (flowers or flour)	do	15
Water to make	gallons	50

This is prepared as already indicated. While this wash may be stored without injury, it is better to prepare the "concentrate," as later described, if it is to be stored.

COMMERCIAL LIME-SULPHUR CONCENTRATES.

The inconvenience experienced in preparing the lime-sulphur wash according to the foregoing formula by cooking with steam or in open kettles at home has been one of the principal objections to this spray. Manufacturers have, therefore, put on the market concentrated solutions of lime-sulphur which have only to be diluted with water for use. These commercial washes, if used at proper strength, have proved to be quite as satisfactory in controlling the scale as the old-formula lime-sulphur wash, and, although somewhat more expensive, have been adopted by many of the commercial orchardists in prefer-

ence to making the wash at home. They are especially useful for the smaller orchardists whose interests do not warrant the construction of a cooking plant.

HOMEMADE LIME-SULPHUR CONCENTRATES.

The question of the preparation at home of concentrated lime-sulphur solutions which will not crystallize upon cooling, thus duplicating the commercial product, has been investigated by the Bureau of Entomology, as well as by numerous experiment station entomologists, notably by Profs. Stewart, Cordley, Parrott, and others. It has been demonstrated that it is practicable for orchardists to prepare concentrated stock solutions of lime-sulphur wash for immediate or later use, and many orchardists employ this plan. The necessary details for the preparation at home of lime-sulphur concentrates are given in Farmers' Bulletin 650 of this department. Those interested in the preparation for storage of lime-sulphur concentrate should write for this publication.

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